

CLAIMS

What is claimed is:

1 1. A method of treating a subterranean formation penetrated by a well, the method
2 comprising the steps of:

3 (a) forming a treatment fluid comprising:

4 1) water;

5 2) a water-soluble polysaccharide capable of increasing the viscosity of the
6 water and present in a sufficient concentration to increase the viscosity of
7 the water; and

8 3) a breaker comprising at least one member selected from the group
9 consisting of a source of chlorite ions and a source of hypochlorite ions,
10 wherein the breaker is present in a sufficient concentration to break the
11 viscosity of the treatment fluid after introduction of the fluid into the
12 subterranean formation;

13 (b) at any stage of forming the treatment fluid, adding a breaker moderator
14 comprising at least one member selected from the group consisting of a source of
15 magnesium ions and a source of calcium ions to provide a sufficient concentration of the
16 breaker moderator to control the break rate of the fluid; and

17 (c) introducing the treatment fluid into the well and into contact with the
18 formation.

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1 2. A method of treating a subterranean formation penetrated by a well, the method
2 comprising the steps of:

3 (a) forming a treatment fluid, comprising:

4 1) water;

5 2) a water-soluble polysaccharide and a crosslinking agent for the water-
6 soluble polysaccharide, which are present in a sufficient concentration to
7 effect crosslinking of the of the polysaccharide and increase the viscosity
8 of the water;

9 3) a breaker comprising at least one member selected from the group
10 consisting of a source of chlorite ions and a source of hypochlorite ions,
11 wherein the breaker is present in a sufficient concentration to break the
12 viscosity of the treatment fluid after introduction of the fluid into the
13 subterranean formation; and

14 4) a breaker moderator comprising at least one member selected from the
15 group consisting of a source of magnesium ions and a source of calcium
16 ions, wherein the breaker moderator is present in a sufficient concentration
17 to control the break rate of the fluid; and

18 (b) introducing the treatment fluid into the well and into contact with the
19 formation.

1 3. The method of Claims 1 or 2, wherein the formation has a static temperature of
2 200°F and above.

1 4. The method of Claim 3, wherein the formation has a static temperature of up to
2 350°F.

1 5. The method of Claims 1 or 2, wherein the step of introducing the treatment fluid
2 into the well and into contact with the formation is at a rate and pressure sufficient to
3 fracture the formation.

- 1 6. The method of Claims 4, wherein the step of introducing the treatment fluid into
2 the well and into contact with the formation is at a rate and pressure sufficient to
3 fracture the formation.
- 1 7. The method of Claim 6, wherein the treatment fluid further comprises a proppant.
- 1 8. The method of Claim 4, wherein the treatment fluid is adapted to break within 1
2 to 24 hours after being introduced into the well and into contact with the formation.
- 1 9. The method of Claim 4, wherein the polysaccharide comprises at least one
2 member selected from the group consisting of galactomannans, modified or
3 derivatized galactomannans, and cellulose derivatives.
- 1 10. The method of Claims 4, wherein the polysaccharide comprises at least one
2 member selected from the group consisting of guar, hydroxypropylguar,
3 carboxymethylhydroxypropylguar, carboxymethylhydroxyethylcellulose,
4 carboxymethylcellulose, and hydroxyethylcellulose grafted with vinylphosphonic
5 acid.
- 1 11. The method of Claim 2, wherein the crosslinking agent comprises at least one
2 member selected from the group consisting of borate-releasing compounds, a source
3 of titanium ions, a source of zirconium ions, a source of antimony ions, and a source
4 of aluminum ions.
- 1 12. The method of Claim 11, wherein the borate releasing compound comprises
2 ulexite.
- 1 13. The method of Claims 1 or 2, wherein the breaker comprises at least one member
2 selected from the group consisting of alkali metal chlorites.

- 1 14. The method of Claim 6, wherein the breaker comprises at least one member
2 selected from the group consisting of alkali metal chlorites.
- 1 15. The method of Claim 14, wherein the breaker comprises sodium chlorite.
- 1 16. The method of Claims 1 or 2, wherein the breaker moderator comprises at least
2 one member selected from the group consisting of a source of magnesium ions.
- 1 17. The method of Claim 6, wherein the breaker moderator comprises at least one
2 member selected from the group consisting of a source of magnesium ions.
- 1 18. The method of Claim 14, wherein the breaker moderator comprises at least one
2 member selected from the group consisting of a source of magnesium ions.
- 1 19. The method of Claim 18, wherein the breaker moderator comprises at least one
2 member selected from the group consisting of magnesium chloride, magnesium
3 acetate, and magnesium sulfate.
- 1 20. The method of Claims 1 or 2, wherein the breaker moderator comprises at least
2 one member selected from the group consisting of: calcium chloride, calcium acetate,
3 and calcium nitrate.
- 1 21. The method of Claim 14, wherein the breaker moderator comprises at least one
2 member selected from the group consisting of: calcium chloride, calcium acetate, and
3 calcium nitrate.
- 1 22. The method of Claims 1 or 2, wherein the fluid further comprises a pH adjusting
2 agent present in a sufficient concentration to adjust the pH of the fluid to be at least
3 10.

1 23. The method of Claim 14, wherein the fluid further comprises a pH adjusting agent
2 present in a sufficient concentration to adjust the pH of the fluid to be at least 10.

1 24. A treatment fluid for treating a subterranean formation penetrated by a well, the
2 fluid comprising:

3 (a) water;

4 (b) a water-soluble polysaccharide capable of increasing the viscosity of the
5 water and present in a sufficient concentration to increase the viscosity of the water;

6 (c) a breaker comprising at least one member selected from the group
7 consisting of a source of chlorite ions and a source of hypochlorite ions, wherein the
8 breaker is present in a sufficient concentration to break the treatment fluid after
9 introduction of the fluid into the subterranean formation; and

10 (d) a breaker moderator comprising at least one member selected from the
11 group consisting of a source of magnesium ions and a source of calcium ions,
12 wherein the breaker moderator is present in a sufficient concentration to control the
13 break rate of the fluid, and wherein at least part of the concentration of the breaker
14 moderator is added to the fluid.

1 25. A treatment fluid for treating a subterranean formation penetrated by a well, the
2 fluid comprising:

3 (a) water;

4 (b) a water-soluble polysaccharide and a crosslinking agent for the water-soluble
5 polysaccharide, which are present in a sufficient concentration to effect crosslinking
6 of the of the polysaccharide and increase the viscosity of the water;

7 (c) a breaker comprising at least one member selected from the group consisting
8 of a source of chlorite ions and a source of hypochlorite ions, wherein the breaker is
9 present in a sufficient concentration to break the viscosity of the treatment fluid after
10 introduction of the fluid into the subterranean formation; and

11 (d) a breaker moderator comprising at least one member selected from the group
12 consisting of a source of magnesium ions and a source of calcium ions, wherein the
13 breaker moderator is present in a sufficient concentration to control the break rate of
14 the fluid, and wherein at least part of the concentration of the breaker moderator is
15 added to the fluid.

1 26. The treatment fluid of Claims 24 or 25, wherein the treatment fluid breaks within
2 6 to 24 hours for at least one temperature in the range of 200°F to 350°F.

1 27. The treatment fluid of Claim 26, wherein the treatment fluid further comprises a
2 proppant.

1 28. The treatment fluid of Claim 26, wherein the polysaccharide comprises at least
2 one member selected from the group consisting of galactomannans, modified or
3 derivatized galactomannans, and cellulose derivatives.

1 29. The treatment fluid of Claim 26, wherein the polysaccharide comprises at least
2 one member selected from the group consisting of guar, hydroxypropylguar,
3 carboxymethylhydroxypropylguar, carboxymethylhydroxyethylcellulose,
4 carboxymethylcellulose, and hydroxyethylcellulose grafted with vinyl phosphonic
5 acid.

1 30. The treatment fluid of Claim 26, wherein the crosslinking agent comprises at least
2 one member selected from the group consisting of borate-releasing compounds, a
3 source of titanium ions, a source of zirconium ions, a source of antimony ions, and a
4 source of aluminum ions.

1 31. The treatment fluid of Claims 30, wherein the borate releasing compound
2 comprises ulexite.

1 32. The treatment fluid of Claims 24 or 25, wherein the breaker comprises at least
2 one member selected from the group consisting of alkali metal chlorites.

1 33. The treatment fluid of Claim 26, wherein the breaker comprises at least one
2 member selected from the group consisting of alkali metal chlorites.

1 34. The treatment fluid of Claim 33, wherein the breaker comprises sodium chlorite.

1 35. The treatment fluid of Claims 24 or 25, wherein the breaker moderator comprises
2 at least one member selected from the group consisting of a source of magnesium
3 ions.

1 36. The treatment fluid of Claim 33, wherein the breaker moderator comprises at least
2 one member selected from the group consisting of a source of magnesium ions.
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- 1 37. The treatment fluid of Claim 24 or 25, wherein the breaker moderator comprises
2 at least one member selected from the group consisting of magnesium chloride,
3 magnesium acetate, and magnesium sulfate.
- 1 38. The treatment fluid of Claim 26, wherein the breaker moderator comprises at least
2 one member selected from the group consisting of magnesium chloride, magnesium
3 acetate, and magnesium sulfate.
- 1 39. The treatment fluid of Claim 24 or 25, wherein the breaker moderator comprises
2 at least one member selected from the group consisting of: calcium chloride, calcium
3 acetate, and calcium nitrate.
- 1 40. The treatment fluid of Claim 33, wherein the breaker moderator comprises at least
2 one member selected from the group consisting of: calcium chloride, calcium acetate,
3 and calcium nitrate.
- 1 41. The treatment fluid of Claims 24 or 25, wherein the fluid further comprises a pH
2 adjusting agent present in a sufficient concentration to adjust the pH of the fluid to be
3 at least 10.
- 1 42. The treatment fluid of Claim 33, wherein the fluid further comprises a pH
2 adjusting agent present in a sufficient concentration to adjust the pH of the fluid to be
3 at least 10.
- 1 43. The treatment fluid of Claims 24 or 25, wherein part of the concentration of the
2 breaker moderator is naturally occurring in the water.
- 1 44. The treatment fluid of Claims 24 or 25, wherein the concentration of the breaker
2 moderator is at least about 15 mg/L.

1 45. A method of treating a subterranean formation penetrated by a well, the method
2 comprising the steps of:

3 (a) forming a treatment fluid comprising:

4 1) water,

5 2) a water-soluble polysaccharide capable of increasing the viscosity of the
6 water and present in a sufficient concentration to increase the viscosity of
7 the water; and

8 3) a breaker comprising at least one member selected from the group
9 consisting of a source of chlorite ions and a source of hypochlorite ions,
10 wherein the breaker is present in a sufficient concentration to break the
11 viscosity of the treatment fluid after introduction of the fluid into the
12 subterranean formation;

13 (b) selecting the water for naturally including a breaker modifier comprising
14 at least one member selected from the group consisting of a source of magnesium ions
15 and a source of calcium ions, where the breaker modifier is present in a sufficient
16 concentration to control the break rate of the treatment fluid; and

17 (c) introducing the treatment fluid into the well and into contact with the
18 formation.

1 46. A method of treating a subterranean formation penetrated by a well, the method
2 comprising the steps of:

3 (a) forming a treatment fluid comprising:

4 1) water;

5 2) a water-soluble polysaccharide capable of increasing the viscosity of the
6 water and present in a sufficient concentration to increase the viscosity of
7 the water; and

8 3) a breaker comprising at least one member selected from the group
9 consisting of a source of chlorite ions and a source of hypochlorite ions,
10 wherein the breaker is present in a sufficient concentration to break the
11 viscosity of the treatment fluid after introduction of the fluid into the
12 subterranean formation;

13 (b) at any stage of forming the treatment fluid, adding at least one member
14 selected from the group consisting of a source of magnesium ions and a source of
15 calcium ions to provide at total ionic concentration of at least about 15 mg/L; and

16 (c) introducing the treatment fluid into the well and into contact with the
17 formation.